The Institute of Physics

BULLETIN

OCTOBER 1957 · VOL. 8 · No. 10

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The Bulletin is published by The Institute of Physics for circulation to its members.

Notices to Members

Student Grade : general education requirements

The Board has accepted a recommendation of the Membership and Examinations Committee that the general education regulations shall no longer apply to the Student grade. Any student of a college recognized for the purpose by the Institute, who is following a course of study leading to a qualification recognized by the Board will be eligible for admission to the Student grade. Such a student will be required to comply with the normal requirements of general education before becoming eligible for graduateship or corporate membership.

Forthcoming Meetings

Members may like to have advance notice of the Easter Conference of the Education Group which has usually been held in London. In view of the success of the Joint Conference with the Scottish Branch, however, the Group has decided to hold its 1958 Annual Conference at Bristol University in conjunction with the newly-formed South-Western Branch.

The dates of the conference are April 9, 10 and 11, and it should be possible for members to combine attendance at it with an Easter holiday in the West country. Accommodation has already been booked in Wills Hall. Further details will be announced later.

The Education Group has also arranged an additional lecture meeting. On Wednesday, December 4, Mr. F. I. G. Rawlins

(*Fellow*) of The National Gallery will speak on " Physics and Aesthetics." The meeting is at 6 p.m. at the Institute's House.

The X-ray Analysis Group has arranged an evening meeting at the Institute's House on November 18. Mr. E. E. Smith (*Associate*) of The Radiological Protection Service will speak about radiation protection and the X-ray crystallographic worker. Details of the meeting will be sent to all members of the Group and may be obtained by others on application to the Institute.

The Design of Physics Research Laboratories.

The attention of members is particularly called to the important symposium which the London and Home Counties Branch has arranged for Wednesday, November 27. The meeting will be held at the Royal Institution, Albemarle Street, W.1, at 2.30 p.m. Admission is by **ticket only** but tickets are available, free of charge, to all interested. Application should be made to the Institute. More than 200 tickets have already been requested.

Physical Society Meetings

Members of the Institute are invited to attend the following meetings of The Physica Society :

Oct. 31 Low Temperature Group

" *Reports on the Fifth International Low Temperature Conference* "

Nov. 6 Colour Group

" *Colour and Geology* "

MR. E. A. JOBBINS

" *Gems* "

MR. B. W. ANDERSON

At The Institute of Ophthalmology, at 3.30 p.m.

Vol. 8, October, 1957

The 25th Anniversary of the Manchester and District Branch

(1) By H. LOWERY, D.Sc., M.Ed., F.Inst.P.

(*Principal, South West Essex Technical College, Walthamstow*)

WHEN, in 1916, the late Sir Richard Gregory surveyed the achievements of science and made his plea for the proper appreciation of the work of scientists, he could scarcely have foreseen the enormous, indeed prodigious, strides that all branches of science would make during the succeeding thirty-odd years. His fascinating story, entitled *Discovery or the Spirit and Service of Science* (originally published by Macmillan & Co. ; now re-issued in PAN books) while rightly emphasizing the single-mindedness and formidable obstacles that formed the background of the discoveries of the pioneers, also stressed the substantial benefits that mankind may secure by suitable development and application of the knowledge thus won from nature. It is not without significance that his book was issued during the First World War, though he had in fact written much of it in pre-war years. The sudden national realization that communal survival both in war and in peace depends upon the intelligent use of scientific knowledge stimulated not only publication of this book but also many other enterprises all aimed at directing and influencing public opinion towards the support of large-scale scientific research and its industrial exploitation.

It was in an atmosphere of this kind that The Institute of Physics was founded in 1918. As might be expected, according to present-day standards, its initial growth was slow. Even after twenty years, on the eve of the Second World War, its membership had scarcely reached the thousand mark whereas to-day, thirty-nine years from its foundation, the membership figure is some 6,000, while the Institute's prestige and influence stand at a very high level in scientific, educational, economic, and political circles. Not a little of the effectiveness of the Institute and service to its members is derived from the decentralization of its activities through the creation of local branches for the holding of meetings on general scientific topics, together with a number of technical groups to encourage the development of the applications of certain special physical subjects. Here it must be emphasized that The Institute of Physics is a professional body concerned primarily with the welfare of physicists rather than a learned society, such as The Physical Society, whose sole object is the advancement of the science of physics ; indeed, at all stages of the growth of The Institute of Physics, care has been taken to recognize this distinction.

The decentralization of activities of the Institute began with the formation of the Manchester and District Branch in 1932. It is somewhat difficult to say exactly how the idea to establish a local branch came about. On various visits to London, particularly to attend the Annual Exhibitions of The Physical Society, I had chats with the Secretary of the Institute, who gave me the first hints that a local branch of the Institute would be favoured by the Board though he did not specifically designate a location for it. Subsequent informal conversations with the late Professor J. A. Crowther, then Honorary Secretary of the Institute, and the late Major C. E. S. Phillips, who was Honorary Treasurer, confirmed the idea and led me to make enquiries in the Manchester district both at the University and among local industries as to its possible acceptance. Prior to 1931 there had been little response. Most physicists with whom I discussed the suggested formation of a branch deplored

the multiplying of meetings, feeling that already there existed too many activities for practising physicists to do justice to them all. I believe this was also the view of Professor W. L. (now Sir Lawrence) Bragg, who, as Professor of Physics in the University of Manchester at that time, would naturally be expected to have a strong say in the formation of a branch. His concern seemed to be, quite rightly, that nothing should be done to interfere with or detract from the excellent *physics colloquia* which he had developed in the Physics Department of the University which formed a platform for eminent physicists from all over the country and even from the Continent to expound the latest research developments.

No doubt much of the initial opposition to the formation of a branch derived from our failure to distinguish the subject "Physics" from the profession of physicist. There was never any idea of duplicating existing facilities for the study of physics. On the contrary, the new organization would be concerned with industrial applications of physics and the part which physicists should take in them. It will be remembered that almost from its beginning the Institute had been successful in this field with its special lectures, all published, on "Physics in Industry" by such eminent technologists as Barr, Ewing, Paterson, Mellor, Oxley, Keen, Makower and Desch.

By 1931 I had almost given up hope of the formation of a branch of the Institute in Manchester. I think that the new impetus came from the late Lord Rutherford who held the office of President of the Institute from 1931 to 1933. As is well known, his enthusiasm in any field was highly infectious. After a chat with him I felt that every effort should be made to revive the suggestion. Perhaps two other factors might be cited as not irrelevant to the revival of the idea, namely (*a*) the 1931 Faraday celebrations which had lime-lighted the importance of physical science as the origin of new industries and (*b*) the trade recession which had led to public statements on the need to encourage scientific and technological research. Whatever the real causes, the time seemed ripe for action. Early in 1932 Professor Bragg agreed to give his full support and become first Chairman of the Manchester and District Branch of the Institute. Considerable encouragement was also received from Mr. A. P. M. (later Sir Arthur) Fleming, Director of Research and Education at Messrs. Metropolitan Vickers Electrical Co., Trafford Park, Manchester.

The first Committee was, of course, provisional in character, and met on Friday, December 2, 1932, in the Physics Department of the University. Its members were :— Professor W. L. Bragg (Chairman), Dr. Willis Jackson, Mr. F. Oldham, Mr. S. W. Redfearn, Dr. F. C. Toy, Dr. R. S. Willows and myself as Convenor. Rules for the governance of the Branch were drawn up for submission to a full meeting of members, the expressed aims and objects being as follows :—

"The aim of the Section shall be to obtain special privileges for members such as library facilities, notification of meetings of scientific societies and organizations of interest to physicists and visits to works ; to arrange special meetings of members from time to time to discuss the applications of Physics in various industries and for other purposes ; to keep an appointments register ; to receive and deal with inquiries on the part of individual firms for professional advice and assistance and in other ways to encourage the co-operation between physics and industry."

Two small points may be noted. Firstly, we had used the title *Section* ; this the Board of the Institute changed to Branch. Secondly, the Branch would not discuss professional matters with outside bodies which was obviously the function solely of the Board of the Institute.

The aim of stressing the relations between physics and industry was immediately carried into action by arranging four special lectures and discussions during the early summer of 1933 as follows :—

(*a*) "Physics in the Wool Industries" by S. G. Barker.

(*b*) "Industrial Physics in Spinning and Doubling" by F. P. Slater.

(*c*) " Architectural Acoustics " by G. A. Sutherland.

(*d*) " Hearing Aids for the Deaf " by T. S. Littler.

These lectures were held in the Physics Department of the University with Professor W. L. Bragg in the Chair. They attracted large audiences and, through the kindness of Mr. Fleming, were subsequently published in pamphlet form. A little later, the Institute's special lecture on " Physics in the Building Industry " by Dr. R. E. Stradling was repeated before the Branch and a further series of special lectures was arranged, namely :—

(*a*) " Units of Matter " by Dr. J. M. Nuttall.

(*b*) " Heavy Hydrogen " by Professor J. D. Bernal.

(*c*) " Alloys " by a research team from Messrs. Metropolitan-Vickers Electrical Co. Ltd.

(*d*) " Viscosity " by Professor E. N. da C. Andrade.

These were followed by a number of individual lectures, a demonstration of High Voltage Phenomena by Mr. J. L. Langton at the College of Technology, and a Two-day Conference on " Industrial Applications of X-ray Crystallography."

Spurred on by these successes, the Branch then embarked upon a really ambitious venture, namely, the holding of a three-day Conference and Exhibition on Industrial Physics in the Spring of 1935 (March 28–30). To give point to the Conference a topical subject was chosen which was likely to encourage the support of industrial organizations and allow plenty of scope for striking practical demonstrations. In choosing " Vacuum Devices in Research and Industry," the Committee hit upon a subject that captured the public imagination. Professor Bragg's broadcast talk about the Conference from the North Region of the B.B.C., Mr. (now Sir) Robert Watson Watt's Public Lecture on "Cathode Ray Tubes in Industry" and the admission of the public to the Exhibition created a lively interest shown through letters to the press and correspondence with the Honorary Branch Secretary on scientific questions. Over 3,000 persons visited the Exhibition.

Some details of this Conference may be of interest. It was held in the Physics Laboratories of the University of Manchester which had to be specially wired from the electric mains to cope with the power demands of the numerous industrial firms taking part in the Exhibition of apparatus and demonstrations. Owing to the large membership, amounting to 600 persons from all parts of the country, the opening ceremony had to be transferred to the large Chemistry Theatre to hear the speeches by Sir William Clare Lees and Sir John Stopford. Then followed a series of lectures on Modern Electrical Illuminating Devices by J. W. Ryde ; Application of Photo-electric Cells by T. M. C. Lance and R. C. Walker ; The Cathode Ray Oscillograph in Research and Industry by L. H. Bedford ; Recent Applications of Mercury Vapour Rectifiers and Thyratrons by L. J. Davies and A. L. Whiteley ; High Tension Vacuum Tube Devices in Research and Industry by J. D. Cockcroft ; and X-rays in Industry by G. Shearer. Visits were paid to the Research Laboratories and Works of Messrs. Metropolitan-Vickers Electrical Co. Ltd., the British Cotton Industry Research Association ; Messrs. Tootal Broadhurst Lee Co. Ltd., and the Post Office Telephones Building. Special arrangements and visits to places of interest in Manchester were made for lady visitors to the Conference by a Committee under the Chairmanship of Lady Bragg. The Conference Dinner held in the Large Hall of the College of Technology was a brilliant function, the chief guests being drawn from many phases of civic, academic and industrial life.

" Talking points " of the various addresses reflect for us to-day the changes that have taken place in industrial physics during the past 25 years, speeded of course by a world war. Mr. J. W. Ryde discussed at length the " recent " increase of efficiency of tungsten filament lamps from 15% to 20% and then proceeded to examine the " future " possible use of electric discharge lamps as normal light sources. What are now common-

place uses of photo-electric cells were hailed as great advances, for example, in counting devices, and colour matching. The faithful amplification of light intensity fluctuations between 10 and 200,000 times per second were given very serious consideration. The thyratron had just been evolved ; its utility in automatic control called forth enthusiasm both in the lecture discussions and in the Exhibition, especially when it was emphasized that until its advent the means of interrupting an electric circuit had not altered fundamentally since Faraday's time, a hundred years before. J. D. Cockcroft reported exciting new applications of high voltage phenomena at the Cavendish Laboratory, Cambridge, from a mere 200 kV in 1928 to a million volts in 1934, with favourable prospects for an early increase to two million volts. The popular press made much capital out of his references to the use of high voltages in producing transformation of matter particularly in regard to the generation of artificial radioactivity. " While work in this field is likely to develop rapidly, it is too early yet to predict possible industrial consequences." We have certainly come a long way since 1935 and it is gratifying that Sir John, as he now is, who has played perhaps the foremost part in recent large-scale developments in this field, is the immediate Past-President of The Institute of Physics.

Enough has now been said to indicate the thrills of those opening days of the first Institute Local Branch in Manchester. As has often happened in the past, Manchester's pioneering work was to prepare for something similar in London. The foundation of the London and Home Counties Branch took place four years later, being in turn followed by other local Branches now numbering nine, together with seven specialized subject groups.

(2) By D. G. DRUMMOND, M.Sc., Ph.D., F.Inst.P.

(*British Cotton Industry Research Association, Manchester*)

IN 1932, when the Institute itself was fourteen years old, a group of north-country members, on the initiative of Dr. H. Lowery, decided that they were not being adequately catered for, and applied to the Board requesting, " the formation of a Local Section in the Manchester Area in accordance with No. 110 of the Articles of Association of the Institute." The Board acceded to this request, and at a Preliminary General Meeting on November 18, 1932, under the chairmanship of Professor W. L. (now Sir Lawrence) Bragg, who became the first Chairman of the Section, the 28 persons present proceeded to the election of a Provisional Committee to formulate rules for the Section and to inaugurate its activities. The first general meeting after that, called primarily to approve and adopt the Rules and install a regular Committee, was addressed by Mr. A. P. M. (later Sir Arthur) Fleming of Metrovicks on " Research from an Industrial Point of View," thus underlining from the start one of the main functions of the Institute—the bringing together of science and industry.

In the years before the war the pattern of activities soon settled down to include a couple of evening lectures each winter but with the main effort put into a " Summer Course " of lectures given on four afternoons spread over two or three weeks in the summer Rather surprisingly the replies from various firms as to whether their employees could more conveniently attend afternoon or evening meetings had shown a majority in favour of afternoons.

The high water mark of the pre-war years was a two-day conference in 1935, organized by the Institute on a national scale but actively supported by the Manchester and District Local Section which was responsible not only for the local organization but for the selection of the subject—" Vacuum Devices in Research and Industry." The report of this meeting reads impressively as follows :

" The conference included the reading of papers, discussions, a public discourse, a

broadcast talk, a dinner, works visits and an exhibition of books and apparatus. The conference was attended by 600 members, and the exhibition, which was open to the public on one day, was visited by 3,000 persons. Special arrangements were made for the entertainment of the lady members of the conference. A Conference Handbook and a Catalogue of the exhibition were issued."

Attendances at Branch meetings have never again even approached such figures.

Shortly after this, a letter from Dr. Lang on behalf of the Board suggested changing the term "Local Section" to "Local Centre" or "Local Branch." The committee commented with Mancunian forthrightness that "'Local Centre' was intolerable, though 'Local Branch' was unobjectionable, but that there was no reason why the term 'Local Section' should be changed." However, changed it was, and we became "The Manchester and District Branch" and have remained so ever since. The "— and District" covered by the title is not now what it was in 1936, however, for it must be remembered that at that time the whole of the North of England from the Tyne to the Midlands, as well as all of Wales was nominally included—the Midland Branch had been formed in 1935. Indeed, even as lately as 1949, under Dr. Vick's Chairmanship, it was seriously suggested that the name of the Branch be altered to "The North of England Branch." This was never implemented for in that same year the situation was changed by the formation of a "North Eastern Branch" centred on Newcastle-on-Tyne. This had the full support of members of the Manchester Branch Committee who felt that they were no more able to cater for the needs of Tyneside than was London for Manchester.

The remoter parts of the "district," however, were still not adequately served and in 1951 a request came from Professor Palmer of Hull that the Manchester Branch should arrange a meeting in Hull each session. The committee in fact agreed to do this but there was some delay in making the arrangements and in the following year the Yorkshire Branch was formed, taking Hull out of our area. It is interesting to note that when negotiations for the formation of the Liverpool Branch were already in progress in 1954 a request was received from Professor Andrew, who was at the time unaware of these negotiations, that the Manchester Branch should hold one or two meetings each session in Bangor. Here again, Bangor passed out of our district before the request could be implemented. It remains to be seen whether the Branch has now become sufficiently compact to be able to satisfy the members in its present area. Certainly the splitting away of the other Branches mentioned has greatly improved the service to members in the areas concerned.

In the earlier days of the Manchester and District Branch, Institute members in Leeds, in particular, took a significant part in the Branch activities, as is shown by the appearance on the committee lists of names such as W. T. Astbury and E. G. Stoner and, rather later, E. G. Cox, who was our Chairman between 1946 and 1948, as well as by the arranging of several visits to, and meetings at, Leeds University. Indeed, the first "summer visit" of the Branch was made to Leeds University in May, 1936, while Manchester University Physics Department was not formally visited until 1949.

It was probably for the convenience of members from outlying parts of the district that the original "Summer Courses" of lectures spread over two or three weeks were condensed in 1937 and the following years to a "Summer Conference" held on two consecutive days—usually a Thursday and Friday—and at the same time given a more definite and restricted theme. These Summer Conferences were continued until 1950 with two interruptions—one during the war years from 1940 to 1945 inclusive, and one in 1949, the year of the Institute's first quadrennial convention at Buxton—and their dates and subjects are given in an appendix to this note. After 1950 they ceased, though a one-day conference on "The Optical and Electron Microscopical Properties of Textile Fibres"—a subject of particular local interest—was held in October, 1952, and was well supported. This last arose from comments that

the Branch was not paying sufficient attention to the applications of physics in the textile industry, and since then a proportion of meetings of relevance in this field has been included in our programme.

There seem to be two factors accounting for this dropping of the summer conferences—the regional devolution due to the formation of new Branches has made it less necessary to minimise the travelling involved in attending meetings of the Branch, and the development of the Group system has been felt to remove to some degree the need for single-subject conferences in the Branch. The pattern of activity has, therefore, changed and at present the principal impact on the membership of the Branch as a whole comes through the evening lectures in the winter, of which a series of six at monthly intervals is normally arranged. These are in no sense a " course " of lectures but are deliberately made as varied as is conveniently possible, to suit tastes ranging from the academic to the industrial, from geophysics to atomic physics, and from biophysics to astronomy. Something has been lost in this swing, for the opportunities for social contacts between members are greater in a compact " conference " than at isolated meetings and the feeling is growing that more, and more varied, opportunities for members to meet and get to know each other must be devised. The need has been partially met by the annual dinner which has been held in each year since 1951 and, for those who come, has been a most enjoyable highlight of the year, enhanced in the last three or four years by post-prandial demonstrations, organized by Dr. P. S. H. Henry, of entertaining or mystifying experiments or curiosities of science which usually stimulate a lively interest. This seems not to be enough, however, and a more popular form of social gathering would be a valuable addition to the annual program.

When war broke out in 1939, the activities of the Branch were immediately curtailed—by black out restrictions as well as by the general preoccupation with more urgent matters—and indeed, between the conference of July, 1939, and the Annual General Meeting of May, 1941, there is only record of one meeting, though thereafter there was some revival. It had been agreed that the existing committee should remain in office for the duration of the war, and this team, under the Chairmanship of Dr. F. C. Toy, and with Dr. W. H. Taylor as Secretary, kept the Branch alive throughout those difficult times and indeed was steadily building up the tempo of activity again in the latter years of the war. One is somewhat startled, in the light of later experience of " security," to find on record in November, 1941, a lecture by Professor Oliphant, on " Physics in the United States and recent practical applications of Nuclear Physics." The attendance at this was 50, a figure which can be set without comment against an audience of 200 in the preceding July to hear Dr. H. Spencer Jones speak on " The 200-inch Telescope." Another noteworthy meeting of those times, on October 16, 1943, was the inaugural meeting of the X-ray Analysis Group. This was run as a joint meeting of the Branch with persons interested in the formation of the Group, and took the form of a half-day conference under the chairmanship of Dr. F. C. Toy. Manchester has thus had a hand in the early development of the Group system as well as that of the Branches.

In the latter years of the war it is a noticeable feature that almost every meeting was held jointly with some other society, among them The Institution of Electronics, The Illuminating Engineering Society and The Manchester Literary and Philosophical Society. Clearly it was to the advantage of the societies to share their arrangements and facilities at the time, and early in 1946 one finds this trend receiving an embodiment in the formation of The Manchester Federation of Scientific Societies. The Branch supported this venture from the start and members have derived the benefit of the joint " Calendar of Meetings " in the Manchester area. It is perhaps an anomaly that since the formation of the Federation, the proportion of our meetings which have been held jointly with other societies has fallen sharply, but, on the other hand, individual members are now freely invited to attend the meetings

of the other societies in the Federation so that our facilities have in fact been enlarged.

Apart from conferences and lecture meetings, visits to works or laboratories have come to be a permanent feature of the annual program of the Branch, and in only one year since the war is there no record of at least one such visit. The afternoon visit to Leeds University in 1936 has already been mentioned but this was not followed up until 1938 when two evening visits were arranged—to The Shirley Institute in April, and to The Manchester College of Technology in December. A memorable visit to Pilkington's plate glass works at St. Helens in 1939 ended the pre-war series and there followed a gap until March, 1943, when a second visit to The Shirley Institute was made (Dr. F. C. Toy was Chairman of the Branch and also Director of The Shirley Institute). This was a joint visit with the Optical Group of the Physical Society and a special feature was made of the, then novel, Electron Microscope. The following year a visit was made to the Christie Hospital, another great standby of the Branch.

At the end of the war Dr. Toy made way for Professor Hartree as Chairman, and Dr. Taylor for Dr. Vick as Secretary, and the regular rotation of ordinary members of committee was resumed. It is perhaps worth noting that we have always tried to keep the committee as representative of various interests as possible, and to avoid clique formation and draw in as many individuals as possible by eschewing second terms of office on the committee. There are only three instances in the whole history of the Branch of a person who has already served a term as an ordinary member of committee being later re-elected for a further term, and this general principle extends even to the office of Honorary Secretary, for only two out of the eight secretaries have had previous experience on the committee before taking over. Continuity has been strengthened by asking the immediate Past-Chairman to remain as an "elder statesman" during the period of office of his successor, and recently the principle has been established of strengthening contact with the central organization of the Institute by co-opting to our committee any member of the Board who happens to live within the area of the Branch.

The immediate post-war years were boom years for scientific societies generally and, since in our case they also coincided with the energetic secretaryship of Dr. F. A. Vick, it is not surprising to find a great burst of activity. In the two years 1946 and 1947 there were no fewer than 22 meetings, two of which were full scale two-day conferences (each attended by 200 people) and five were visits which included Sheffield University (twice—to different departments), Liverpool University, the L.M.S. Research Laboratories at Derby, and Messrs. Ferranti Ltd. at Moston. In 1946 the experiment was also made of holding a small informal dinner after one meeting, an experiment which was not repeated, though arrangements were made about this time to serve light refreshments before meetings. The latter facility unfortunately does not seem to have been long continued after our normal meeting place was transferred from the Schuster Theatre to the new Bragg Theatre in Manchester University. In passing, it is interesting to note that our first meeting in the new venue, in May, 1946, was addressed, on the subject of "Electronic Semiconductors" by our present Chairman, Dr. R. W. Sillars.

The high level of activity of the immediate post-war years has not been maintained, nor, with the gradual return to normality was it either feasible or desirable that it should be, but in most years there has been at least one meeting of a special nature, beyond the normal program. In 1954, for instance, a Saturday afternoon conference on "The Teaching of Optics," held jointly with the Education Group and the Science Masters' Association, proved most successful, and in 1956, in response to requests from the floor at our Annual General Meetings, the Branch, again in company with the Education Group, made its first—but surely not its last—incursion into the field of the social implications of science. This was in a Saturday afternoon meeting on "Ethical Problems confronting a Young Scientist in the Atomic

Age." It was publicized beyond the Institute's own membership and attracted an audience of 160.

This year a special meeting in the form of a Conversazione is being arranged to mark the twenty-fifth year of the Branch's existence. We intend that, by inaugurating a new effort to provide more opportunities for members to meet socially, it will also form a spring board into the next twenty-five years.

Honorary Officers of the Manchester & District Branch since its formation.

Chairmen

Professor Sir Lawrence Bragg, O.B.E., F.Inst.P., F.R.S.
(1933–1937)

Dr. F. C. Toy, C.B.E., F.Inst.P.
(1937–1945)

Professor D. R. Hartree, F.Inst.P., F.R.S.
(1945–1946)

Professor E. G. Cox, F.Inst.P., F.R.S.
(1946–1948)

Professor F. A. Vick, O.B.E., F.Inst.P., A.M.I.E.E.
(1948–1951)

Mr. W. J. Meredith, F.Inst.P.
(1951–1955)

Dr. R. W. Sillars, F.Inst.P., M.I.E.E.
(1955–)

Honorary Secretaries

Dr. H. Lowery, F.Inst.P.
(1933–1936)

Professor S. Tolansky, F.Inst.P., F.R.S.
(1936–1937)

Dr. C. Sykes, C.B.E., F.Inst.P., F.R.S.
(1937–1938)

Dr. W. H. Taylor, F.Inst.P.
(1938–1945)

Professor F. A. Vick, O.B.E., F.Inst.P., A.M.I.E.E.
(1945–1948)

Dr. A. Hargreaves, F.Inst.P.
(1948–1952)

Professor C. C. Butler, A.Inst.P.
(1952–1953)

Dr. D. G. Drummond, F.Inst.P.
(1953–)

Sir Lawrence Bragg, O.B.E. F.Inst.P., F.R.S.

Dr. F. C. Toy, C.B.E., F.Inst.P.

Professor D. R. Hartree, F.Inst.P., F.R.S.

Professor E. G. Cox, F.Inst.P., F.R.S.

Professor F. A. Vick, O.B.E., F.Inst.P., A.M.I.E.E.

Mr. W. J. Meredith, F.Inst.P.

Dr. R. W. Sillars, F.Inst.P., M.I.E.E.

Dr. H. Lowery, F.Inst.P.

Professor S. Tolansky, F.Inst.P., F.R.S.

Dr. C. Sykes, C.B.E., F.Inst.P., F.R.S.

Dr. W. H. Taylor, F.Inst.P.

Dr. A. Hargreaves, F.Inst.P.

Dr. D. G. Drummond, F.Inst.P.

Moscow Journey

By K. A. G. MENDELSSOHN, M.A., D.Phil., F.R.S.
(*Reader in Physics, University of Oxford*)

On June 15 I received a telegram from the Academy of Sciences in Moscow inviting me, together with five other physicists from this country, to attend a low temperature conference beginning on July 2. Apart from an informal and rather vague enquiry barely a week earlier, this was the first we heard about the meeting. However, the telegram was quite explicit and apart from calling off some other engagements, getting visas, booking flights and finding a sum total of £900 for fares, everything was plain sailing. The conference was the fourth annual low temperature meeting organized by the Academy and it was the first one of its kind to which foreigners were invited. The six of us were the only visitors from abroad, and the conference was held at Kapitza's laboratory, the Institute for Physical Problems. In 1935 Kapitza had gone from Cambridge, where he was the director of the Royal Society Mond Laboratory, on a visit to Russia from which he did not return. Whatever may have happened at the time, the outcome was that the Russians built for him a large laboratory and bought his apparatus for making very high magnetic fields from Cambridge. Since then quite a number of important papers of his have appeared, ranging from the description of an expansion turbine for the liquefaction of oxygen to investigations into the superfluid properties of helium. We thus were not only looking forward to meeting our Russian colleagues at a low temperature conference but also to seeing their experimental work. Another attraction was the opportunity of discussing personally a number of most interesting theories in the low temperature field advanced by Landau and his co-workers.

The following notes are not intended to provide an account of physics in the Soviet Union or to present an analysis of conditions there.* They were jotted down within a week after our return from Moscow in an attempt to record the impressions—necessarily very limited and often incoherent—gathered in ten crowded days.

At Prague airport, that curious half way house between the two worlds, we were greeted by the screaming jets of the Tupolev 104 which took us to Moscow. This is a twin jet carrying—in great comfort—50 passengers, cruising at a height of between 35,000 and 37,000 feet and at a speed of over 500 m.p.h. The distance Prague-Moscow is one thousand miles as the crow flies. Our crow did not fly in a straight line and I estimated the distance actually covered by the flight as nearer 1,200 miles. Even so, the time between runways was only 2 hours 20 minutes. Wines, caviare and vodka and an excellent meal are served aloft and nobody had to use the oxygen masks which are installed at every seat. The place of the " no smoking " sign is taken by an altimeter whose hand turned with alarming rapidity as we descended towards our destination. Safety belts are not provided and were not needed, in spite of the fact that the runway is touched at a considerable speed. We saw at Moscow airport a revised version of this aircraft, the Tu 104A as well as the new four-jet Tu 110 which will carry 70 and 100 passengers respectively at speeds of over 600 m.p.h. These ships together with the new four engined turbo-props " Moskva " and " Ukraina " will greatly ease and accelerate communications over the vast area of the Union and of China.

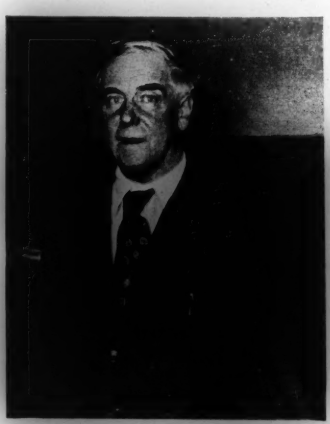
At Moscow airport we were met by some of our colleagues and by the representative of the Academy who took us to the Leningradskaya Hotel, a sky-scraper of the late Stalin period. I was happy to learn that

*An account of the papers presented at the conference has been published in *Nature* of September 7, and some notes of the scientific effort of the Soviet Union appeared in the *Observer* of August 11 and 18.

The conference in session. Front row : Gamzemlidze, Andronikashvili, Khalatnikov and Landau.

after Stalin's death the architect had been severely reprimanded for the outrageous extravagance of his creation. One was continually reminded of Ruskin's worst lapses into Venetian Gothic which were made even more oppressive by the wealth of the materials employed. Unfortunately, the hotel is a typical example of most large buildings put up in Moscow since the war. The ostentatious lack of taste displayed with such grandeur need not fear comparison with Victorian London. It was a relief to see that the many large blocks of flats now under construction have reverted to a more sober pattern. However, there is something impressive in the exuberant vulgarity of the Moscow sky-scrapers. They are, in a way, Texan ; only more so. The Shamrock Hotel in Houston is not a patch on the Leningradskaya and Dallas has nothing to compare with the more elaborate stations of the Moscow Metro.

From the moment of arrival to our departure ten days later we were the guests of the Academy. Unless one has experienced it oneself, it is difficult to get an idea of the hospitality extended by the Soviet authorities to their foreign visitors. Besides the English-speaking representative of the Academy there were two interpreters, a man and a woman, and all of them were looking after the six of us constantly. Also, for the whole of our stay two six-seater cars with their chauffeurs were at our disposal. Although the conference went on for long hours, an official banquet, two visits to the Bolshoi ballet as well as a good deal of sight seeing and shopping were arranged for us. In addition, Kapitza had obtained the use of the government excursion steamer which took all the conference members for a full day's outing on the water ways near Moscow.



Academician P. L. Kapitza, F.R.S.

Academician L. Landau.

Three large meals, breakfast, lunch and dinner were daily consumed by us at the hotel in Russian fashion, i.e. at unspecified times and at irregular intervals. I purposely count in breakfast because we were given such things as grilled steak or sausages on cabbage and found that the minimum quantity of fried eggs obtainable was three. The woman interpreter, inevitably nicknamed " mamma," would discuss the menu with each of us and went to no end of trouble to cater for individual tastes and caprices. The quality of the food was good and it contained besides the body-building ingredients many delicacies such as various kinds of caviare, cold meats and pickles. Although we were quite polite when one evening mamma suggested cauliflower for to-morrow's breakfast, she must have sensed the lack of enthusiasm because it never turned up in the end.

Although the Academy thus provided for us in plenty, they gave each of us an extra 200 roubles of spending money to buy souvenirs. This proved hardly necessary because our Russian colleagues presented us with them. Even so, caviare, long playing records at 8s. apiece and 36 shots of colour film for 6s. proved attractive buys. These articles are, however, exceptions to the general rule that luxury goods are still expensive. On the other hand, the lack of make-up on Russian women seems to be a matter of choice since cosmetics are cheap and readily available. Equally, the white head scarf and the masculine jacket worn by many women over their cotton frocks which give them an appearance of drabness, are evidently more in the nature of a national costume than due to a lack of other types of clothing. All clothing is expensive and forms a major item in the budget. It is balanced by very low rents, three to six pounds per month for a three-room flat. These figures are based on the standard rate of conversion, according to which a low monthly wage comes to 20 pounds while a physics professor makes between £180 and £550, according to his status. The last figure is a little more than the price of the smallest car. There are a few physicists who earn between £750 and £1000 a month. The Soviet Union is no equality state and wishes to attract the best brains into science.

The cordial welcome by our Soviet colleagues, men whose names were familiar but whom we had never met, made life at the conference easy from the start. It was

Professor Peshkov can be pleased; he has the only continuously working He^3 cryostat in the world.

Miss Ptukha lecturing on her work on liquid helium.

gratifying to note how the common interest in physics had paved the way for the personal friendship which sprang up at the first meeting. Somehow, the barriers of nationality, language and ideology receded before the pleasure of discussing personally all those points and queries which had remained obscure when reading each others' papers.

I was the only foreign delegate who had known Kapitza in his Cambridge days, almost 25 years ago, and it was a great pleasure to see him again, aged, but still full of his old vigour. He is the director of the Institute but the low temperature work has now passed into the hands of the next scientific generation of which Peshkov, Alekseevksy and Shalnikov are the foremost representatives. The cryogenic engineering department is headed by Molkov, and there is a large theoretical section under Landau's direction. The latter is certainly one of the most outstanding theoretical physicists of our time and we had been looking forward to meeting him as well as his brilliant colleagues Lifshitz, Ginsburg and Khalatnikov.

Except for our own contributions, the proceedings were in Russian. However, Kapitza had obtained the services of Mr. Boris Belitzky of Moscow Radio whose brilliant simultaneous translation made all the difference to the success of the conference. Belitzky, whose amazing ability must be unique, is a physico-chemist by training. He not only would translate with great accuracy while the Russian speakers were giving their addresses but also their —often heated and rapid—discussions. To do this in diplomatic debates must be difficult enough, but with the quantum mechanics of the Landau school it became a miracle. Belitzky was clearly living the part of the speakers and one completely forgot the head phones and the fact that these were not the voices of the men we saw arguing. The tedium of days of a conference in a strange language, to which we all had looked forward with some trepidation, never materialized. The value of such a translator cannot be assessed too highly and should be noted for future meetings.

We had the impression that the scope of the Soviet low temperature work is more limited than in this country, Holland or

The author discussing with Professor Pomeranchuk (Left).

America. Certain fields, like nuclear alignment or low temperature metal physics, have not elicited the same interest but in the subjects which they have taken up, their experimental work is equal to the best produced elsewhere. In some instances, particularly when making appeal to the great prestige held by fundamental research in the Soviet Union, they are well in advance of developments in the West. For instance, Peshkov, an outstanding experimentalist who first demonstrated the existence of "second sound" in liquid helium, has in operation a cryostat containing the light isotope He^3. Owing to its lower critical data and for other technical reasons this liquid can be pumped down to 0·3°K whereas the practical limit for ordinary helium is 0·9°K. This work has been made possible by the possession of 5 litres of He^3 gas, which is a much larger amount than has been made available for basic research in either the United States* or here. He^3 is the decay product of H^3 which is obtained in nuclear reactions. This support by the Soviet atomic energy authorities clearly shows the high value which they accord to academic research.

Altogether, the impression we gained both in the laboratories of the Academy and of Moscow University is that the value of the scientific project rather than money is the deciding factor. If a line of research or any particular experiment has been considered worth while by the scientists in charge, the necessary means will be forthcoming. Scientific ingenuity is evidently deemed the most precious commodity and is treated as such both by paying for it in high salaries and by providing good facilities for scientific work. Everywhere we looked, instrumentation was excellent and there were also ample workshop facilities with a fair number of technicians and good machine tools. It seems that when the Russians started on their large scale scientific and technological programmes, they did not bother to develop new types of standard equipment but simply copied what they considered best among the Western stock then in existence. Again and again we noticed instruments and machines which, except for the manufacturer's stamp, were indistinguishable from their Western prototypes. While doing this, they probably trained a large force of instrument makers and accumulated manufacturing experience. However, once the basis of production had been established, they created their own development, often with remarkable originality. Thus, while one can buy cameras of well-known type, such as the Leica, later models with entirely new features are now also on the market.

Professor E. M. Lifshitz and (behind him) the translator Boris Belitzky.

With so very much money spent on science, one wonders whether there may not exist a considerable waste, e.g. by pursuing projects of doubtful merit. The caution necessary in avoiding poor research ideas may explain the fierce argument and severe criticism which is characteristic of Russian scientific discussions. It seems to be the custom for the chairman to sum up his own opinion after each paper, and his verdict is sometimes extremely devastating. It is up to the

* Added in proof: At the International Low Temperature Conference at Madison (August 26–31) work on He^3 cryogenics was reported by two American laboratories but neither had as yet developed a continuously working cryostat of the Russian type.

speaker to defend his arguments or results if he thinks this is indicated, or it may happen that a distinguished member of the audience in turn severely criticizes the opinion of the chairman. Westerners who are accustomed to hear a few laudatory remarks from the chair even after the most dismal lecture are surprised by the lack of rancour with which these outspoken debates are conducted. The Russian scientists just never feel it necessary to hide their opinion about any particular piece of work, but that is all there is to it.

Soviet agricultural and industrial products are lavishly displayed at a large permanent exhibition in Moscow to which visitors are invariably taken. Almost all the pavilions are unique architectural horrors but the exhibits, and particularly the scientific ones, are well arranged and interestingly explained. Each small section has its guide, usually a charming young lady, who will illustrate by means of beautifully designed models such things as the new solar power stations, or the working of a thermionic valve, or the constitution of an atom. There is even an operating nuclear reactor in a water tank where one can see the active fuel surrounded by a blue corona of Čerenkov radiation. Again, money was clearly no object but besides that, much thought and care has gone into this popularization of science.

The exhibition, where enthusiastic effort has produced crazy ugliness and side by side a superb display of brilliant achievement, may be more symptomatic of the Soviet Union than its creators realize. It fits well into Moscow, the most fascinating boom town of our time. The city seems equally alive day and night, when building of the huge blocks of apartment houses goes on with undiminished vigour. Old houses are not repaired but allowed to fall into complete ruin. There is no transition between the old and the new, just an eating up of one by the other. This process seems to be constantly accelerated as the economic strength of the country grows. In the space of one generation the Soviet Union has passed from a backward feudalistic state to a position of equality with the foremost industrial powers in the world, and the Russians are fully conscious of their achievement. They are proud of what they have accomplished in the face of war and adversity, by going their own chosen way, and it would be dangerous folly for the West to underrate the ideological force of the revolution.

How free a country the Soviet Union is now was impossible for us to decide but I formed the opinion that this is an equally puzzling problem for the average Soviet citizen. The effects on peoples' mentality of twenty years of complete isolation from the outside world, of political trials and rule by the secret police are impossible for us to comprehend. We must not forget that in the same twenty years, in spite of the war, the country's economy made great advances and that there must be many Russians who consider this the most important aspect. The change from these artificial and rigid conditions to a more liberal mode of life is still so fresh that a whole new generation who has grown up in the meantime is finding it difficult to adjust themselves. Thus, the fact that Russians usually do not like to discuss the political situation with foreigners may either mean that it is actually unsafe to do so or that they fear it may be unsafe. What I am sure of is, that they themselves don't know.

It would for instance have been easy to conclude that the constant attention devoted to us by our interpreters was intended to keep us to some pre-arranged plan. However, personal wishes, expressed at very short notice, to see any particular section of the town were always complied with immediately. In fact, it was possible for us to get off on our own, and we all did. A much more plausible explanation is that it would have been considered as lacking in hospitality if our interpreters had not been at our permanent disposal. Moreover, they would probably have been severely reprimanded if anything untoward had happened to their charges, and Moscow is the only place where I have seen a policeman jump for his life to avoid a car. As it was, the two interpreters and the official from the Academy did their best, with unfailing friendliness and precious little sleep, to keep all of us happy all the time.

The open friendliness shown by our colleagues, by the guides and, in fact, encountered everywhere when we went off on our own became the keynote of our experience. Together with the genuine wish for peace, sometimes fervently expressed by our physicist friends, this friendliness of the people towards foreigners may hold the most valuable promise of better relations in the future.

Forthcoming Institute Meetings

Oct. 16 North Eastern Branch
At the Science Laboratories, South Road, Durham, 5.45 p.m.
Tea 5.15 p.m.
" *Ferromagnetism and Magnetic Materials* "
MR. A. E. DE BARR, F.Inst.P.
(Shirley Institute, Manchester)

Oct. 16 Yorkshire Branch In the Physics Department, University of Leeds, 3 p.m.
" *Nuclear Magnetic Resonance in Solids* "
PROFESSOR E. R. ANDREW, F.Inst.P.
(University College of North Wales, Bangor)

Oct. 18 South Wales Branch
In the Physics Department, University College of South Wales and Monmouthshire, Crumlin, 5.15 p.m.
" *Structural and Physical Properties of Alloys* "
PROFESSOR H. JONES, F.R.S.
(Imperial College of Science and Technology, London)

Oct. 18 South Western Branch In the Physics Department, University of Bristol, 7 p.m.
" *Looking at Dislocations* "
PROFESSOR F. C. FRANK, F.Inst.P., F.R.S.
(University of Bristol)

Oct. 18 Non-Destructive Testing Group At the Institute's House, 6 p.m.
Tea 5.30 p.m.
" *Nuclear Magnetic and Paramagnetic Resonance* "
(An Educational Survey)
DR. L. E. DRAIN
(Atomic Energy Research Establishment, Harwell)

Oct. 22 Midland Branch At the Birmingham Exchange and Engineering Centre, 7 p.m.
" *The Physicist in the Atomic Energy Authority (Industrial Group)* "
MR. L. ROTHERHAM, F.Inst.P.
(United Kingdom Atomic Energy Authority, Risley)

Oct. 23 Manchester and District Branch At the Engineers' Club, Manchester.
Conversazione
to mark the 25th anniversary of the formation of the Manchester Branch of The Institute of Physics.
(Programmes and application forms can be obtained from the Institute.)

Oct. 28 Scottish Branch
In the Department of Natural Philosophy, University of Edinburgh, 7.15 p.m.
" *The Protection of Development and Research by Patents* "
MR. H. J. FITZPATRICK
(H. D. Fitzpatrick & Co., Patent Agents, Glasgow)

Oct. 29 Scottish Branch
At the Royal College of Science and Technology, Glasgow, 7.15 p.m.
" *The Protection of Development and Research by Patients* "
MR. H. J. FITZPATRICK
(H. D. Fitzpatrick & Co., Patent Agents, Glasgow)

Oct. 30 London and Home Counties Branch At 2 p.m.
Visit to the Laboratories of the Morgan Crucible Co.,
Battersea, London, S.W.11
(All tickets now allocated)

Nov. 7 North Eastern Branch At King's College, Newcastle-upon Tyne, 6.15 p.m.
Tea at 5.30 p.m.
" *The Recruitment and Training of Physicists* "
MR. N. CLARKE, F.Inst.P.
(The Institute of Physics)

Nov. 7 Stress Analysis Group At the University College, London, 6 p.m.
A Discussion on
" *Photoelastic Reflection Technique* "
which will be introduced by DR. H. FESSLER and MR. E. J. HAINES
(University of Nottingham)

Nov. 8 Manchester and District Branch
In the Bragg Lecture Theatre, University of Manchester, 6.45 p.m.
" *River Waves* "
PROFESSOR M. J. LIGHTHILL, F.R.S.
(University of Manchester)

Nov. 12 Electronics Group At the Institute's House, 5.30 p.m.
Tea 5 p.m.
" *Crossed Field Interaction in Microwave Valves* "
MR. W. E. WILLSHAW
(Research Laboratory, The General Electric Co. Ltd., Wembley)

Nov. 14 Liverpool and North Wales Branch
In the Physics Department, University College of North Wales, Bangor, 5.45 p.m.
Tea 5 p.m.
" *Polar Wandering and Continental Drift* "
PROFESSOR S. K. RUNCORN, F.Inst.P.
(University of Durham)

Nov. 14 Midland Branch At the Birmingham Exchange and Engineering Centre, 7 p.m.
Branch Annual General Meeting
followed by
" *Time Measurement* "
DR. F. A. B. WARD, F.Inst.P.
(The Science Museum)

Nov. 15-16 North Eastern Branch At Pametrada and King's College, Newcastle-upon-Tyne
A Discussion on
"*Flow Noise*"
(Further details will be circulated later)

Nov. 15 South Wales Branch
In the Physics Department, University of Swansea, 5.15 p.m.
"*Atomic Clock*"
Dr. L. ESSEN
(National Physical Laboratory, Teddington)

Nov. 15 Industrial Spectroscopy Group At the Institute's House
An all day meeting on
"*Spectroscopy in the United Kingdom Atomic Energy Authority*"
(Applications for tickets can be obtained from the Institute)

Nov. 15 Non-Destructive Testing Group At the Institute's House, 6.30 p.m.
Tea 5.45 p.m.
"*The Physical Properties of Glasses and their use in Control tests in the Glass Industry*"
PROFESSOR R. W. DOUGLAS, F.Inst.P.
(Department of Glass Technology, University of Sheffield)

Correspondence

The Clock Paradox

I have just read, in the June issue of the *Bulletin*, Professor Dingle's comments on my criticism of his views. I am perturbed that he should have thought that I imputed to him any improper disrespect towards great men of science. Nothing was further from my mind. On the contrary, I believe that no one can fail to admire, and seek to emulate, his courageous independence and tenacity in fighting for what he believes to be true and right ; in this he embodies the very spirit of science and himself commands my respect even if I, in turn, disagree with him.

I myself agree with Einstein's treatment of the clock retardation problem in his 1905 paper. On the other hand, I disagree with most of what he wrote in the two introductory paragraphs to that paper, from which Professor Dingle has quoted in refutation of my views. I have for some time been trying to write up for publication a satisfactory analysis and interpretation of these two paragraphs in relation to their historical background and in relation to Einstein's subsequent writings. The task is not an easy one. Until it is completed I can only say that Professor Dingle's interpretation of the first of these paragraphs, as an authoritative statement of the fundamental characteristics of electrodynamical phenomena, seems to me to be open to doubt.

I regret that I failed to set out the reasons why the idea of the relativity of accelerated motions, based on the general theory of relativity, does not justify Professor Dingle's inference that all motion is a relative

phenomenon. However, I have since dealt with this question fully in a paper, to appear in the September issue of the *Australian Journal of Physics*, written in reply to Professor Dingle's criticism of my paper on "The Resolution of the Clock Paradox."

Since my paper in the June *Bulletin* was written, Professor Dingle has (*Nature*, v. 179, p. 866) expressed his basic attitude by the statement :

"It should be obvious that if there is an absolute effect which is a function of velocity only, then the velocity is absolute. No manipulation of formulae or devising of ingenious experiments can alter that simple fact."

I believe that, in his recognition of this, and in his clear and emphatic statement of it, he has made an important contribution to the understanding of relativity theory. However, I believe that he is wrong in supposing that this is in any way incompatible with the restricted theory of relativity ; I have discussed this at length in a paper on "The Physical Significance of the Relative Retardation of Clocks," now in draft form, which I will shortly submit for publication elsewhere.

G. BUILDER (*Fellow*).
University of Sydney.

I much appreciate the kind tone of Dr. Builder's letter, which makes me wish I could agree with him about the clock paradox. I am afraid, however, that that is impossible.

If Dr. Builder disagrees with the first two paragraphs of Einstein's paper, the discussion is radically altered. In those paragraphs Einstein stated the two postulates—of relativity and of constant light velocity—on which the rest of the paper is based. If they are not accepted I cannot see why one should accept the rest. Of course, Dr. Builder is perfectly entitled to reject them if he sees good reason for doing so, but in that case the discussion shifts from the clock paradox to the validity of Einstein's postulates. I have made it clear throughout this discussion* that what I say categorically is that if the postulate of relativity is true, then the clocks will not differ on reunion on account of their relative motion. I do not say categorically that they will not differ on this account, though there is little of which I feel more confident, but if experiment should reveal such a difference then I would conclude that the postulate of relativity was wrong. Dr. Builder now apparently agrees with me in this, but our expectations as to the result of the experiment are different.

I cannot understand the last two paragraphs of Dr. Builder's letter. I have never supposed that the statement of mine which he quotes is incompatible with the restricted theory of relativity. It seems to me, as the statement itself says, a mere truism, which it would not be necessary to express if it had not previously been denied. It is quite independent of the restricted theory of relativity and of the question whether there is or is not an absolute effect which is a function of velocity only.

HERBERT DINGLE.

*e.g. *Nature*, 179,1242 (1957)

The Institute's Journals

PRINCIPAL CONTENTS OF THE OCTOBER, 1957, ISSUES

Journal of Scientific Instruments: Volume 34, No. 10

SPECIAL ARTICLE

Physics and the new electronics. By R. A. Smith.

A comparison is made of vacuum electronics and the new electronics using crystalline solids. The very stringent requirements as regards chemical purity and structural perfection of the crystals are discussed. Some experiments which have been made possible through the availability of such high purity crystals are described, including some recent work on semiconductors. A brief account of atomic amplifiers using paramagnetic crystals is also given. The effect of these new developments in the application of the physics of solids on the training of electronic engineers is discussed.

ORIGINAL CONTRIBUTIONS

Energy stabilization of an electrostatic accelerator. By B. Millar, R. Bailey and J. L. W. Churchill.

The energy of the ion beam from the accelerator is measured and stabilized with an accuracy of better than 0·1 per cent. The main energy measuring device is an electrostatic analyser which is energized from a stabilized power supply whose voltage is referred to standard cells. A generating voltmeter is used as an auxiliary measuring device, and a method is described by which a very fast response may be obtained from this instrument. An electron beam loading the generator is used as a fast acting control device, while long term variations are taken up by automatic control of the spray current.

The Leon tube : An instrument for measuring flow speeds in water. By J. F. Kemp.

A description is given of the construction and performance characteristics of an instrument which is capable of measuring flow speeds in water "at a point" over a range of 1 to 14 ft/s. The accuracy at 1 ft/s is approximately 1½ per cent and improves rapidly with increasing speed. The Leon tube is of robust and compact construction and is, in effect, a combination of a differential pressure tube and a differential liquid manometer. The pressure factor of the tube, which is a function of Reynolds number, is most readily determined in a wind tunnel. The instrument has proved to be particularly suitable for the performance of velocity traverses in open channels.

The adjustment of optical systems. By W. S. Blaschke.

The most efficient method of adjusting an optical system to satisfy prescribed Gaussian conditions is given. Additional formulae relate such adjustments to errors present in the components of the system.

New infra-red detectors using indium antimonide. By D. G. Avery, A.Inst.P., D. W. Goodwin and Miss A. E. Rennie.

The paper describes the properties of InSb detectors, at room temperature, using the photoconductive process, and experimental work on sensitive *p-n* junction detectors, cooled to 90°K, used as photovoltaic cells.

The plotting of strain-hysteresis loops. By W. H. Cogill.

The difficulty of measuring the small departures from linearity in the extension of steel specimens subjected to cyclic tensile loading was overcome in this case by comparing the extension of the specimen with that of a member of which the stress-strain curve is, by comparison with the specimen, linear. The scatter of the results obtained with this apparatus indicates that the accuracy of observation of a single-strain hysteresis loop is 4 per cent. The effect was investigated of increasing the direct load while keeping the amplitude of alternating load constant. Stresses were confined to the normal working range.

Spherical aberration in the Fizeau interferometer. By W. G. A. Taylor.

The drawbacks of types of instrument in common use are reviewed. It is shown that primary aberration theory predicts quite accurately the errors introduced even by simple collimators with large aberration. The advantages of using a collimating lens based on a multiple-meniscus design are indicated, and the performances of several lens-systems are compared.

A simple pulse spectrograph. By N. R. Hansen.

The usual saw-tooth time-base of an oscilloscope is replaced by one in which the spot moves with acceleration. Pulses from a radiation detector are displayed as bright dots which occur mainly on the side of the screen where the spot is moving slowly. Integration by time exposure with stationary film gives a record in which a constant-density line is a graph of pulse frequency against pulse height. Visual observation of the spectrum is possible with abundant pulses. The two simple circuits used employ only four tubes between them.

A precision capsule-type pressure gauge for the range 0-20 mm. of mercury. By R. W. Crompton and M. T. Elford.

The construction and calibration of a capsule-type pressure gauge for the range 0–20 mm of mercury is described. Incorporating both mechanical and optical amplification of the capsule movement, the gauge is direct-reading and independent of the nature of the gas under pressure. Sources of error in construction and calibration are examined and an accuracy of better than 1 per cent at 1 mm of mercury and 0·1 per cent at 20 mm of mercury is shown to be obtained.

An electrical resistance analogue with a graded mesh. By P. J. Palmer and S. C. Redshaw.

Details are given for the design and construction of an electrical resistance analogue having a graded mesh. The network is economical to build and, since it consists of eight separate units, it can be assembled in a variety of ways. Thus, for any particular problem in fluid mechanics or elasticity, a suitable and efficient analogue is readily available and it has been successfully used to solve a wide range of problems in these fields.

A mercury-in-glass gas burette. By H. A. Wyllie.

Apparatus is described for transferring increments of gas at low pressures from one section to another of a vacuum system. The measurement of the volume of the gas and the operation of transferring it involve its coming into contact with glass and mercury only.

A sensitive aerodynamic drag balance as an indicator of low air speeds. By J. F. Kemp.

The construction and performance characteristics of a low air-speed indicator, which can be used as standard of comparison for the routine calibration of anemometers in a wind tunnel, are described. The apparatus is essentially a very sensitive drag balance in which the forces acting on a disk are utilized to determine the air speeds. The effective range is from 0·2 to 16 ft/s, and the indicator conforms to all the requirements that may be imposed on a standard of its type.

Second-harmonic acceleration in the cyclotron. By K. E. A. Effat, A.Inst.P., and J. H. Fremlin, F.Inst.P.

It is shown that steady acceleration is possible in the cyclotron, for ions which take an even number of radio-frequency cycles for one revolution, if the centre of revolution is to one side of the dee gap. The acceleration of HD^+ ions, taking two radio-frequency cycles to complete one revolution, has been observed and confirmed by several methods. The contribution of this process to the production and acceleration of multiply charged heavy ions is discussed.

British Journal of Applied Physics: Volume 8, No. 10

ORIGINAL CONTRIBUTIONS

Contact stresses in toroids under radial loads. By H. Fessler and E. Ollerton.

The investigation was restricted to the measurement and calculation of shear stresses only, since these are considered the most important. The stresses were determined using the frozen stress photoelastic technique. A large range of toroids, with positive, zero and negative surface curvatures was tested. The shapes and sizes of the contact areas were in close agreement with Hertzian theory, and the values and positions of the maximum shear stresses agreed with calculated values based on the analysis by Thomas and Hoersch.

It was found that for many practical cases of rolling contact the maximum range of the orthogonal shear stress exceeds the maximum shear stress. This is because the orthogonal shear stress is reversed as one body rolls over the other. A method of calculating the greatest range of orthogonal shear stress has been developed from Hertz's theory. The measured stress ranges and their positions agreed with the calculated values.

The application of a transient method to the measurement of the thermal conductivity of rocks and building materials. By G. Gafner.

A transient method of measuring the thermal conductivity of insulators has been modified to allow measurements to be made on rocks and building materials in the approximate thermal conductivity range 0·008 to 0·07 J/cm °C s, with an accuracy of 7 per cent or better. A detailed description is given of the apparatus, experimental procedure and corrections to be applied to the results obtained.

The measurement of Meyer hardness and Young's modulus on the Rockwell test machine. By D. K. Mackenzie and T. P. Newcombe.

A method is described in which the Rockwell hardness machine is used to determine the Meyer hardness and Young's modulus of a material. Meyer hardness values so derived for a number of materials are compared with those obtained from hardness measurements made on a Vickers hardness machine, and values of Young's modulus compared with figures quoted in standard tables.

High-temperature tensometry and its application to amorphous polyethylene terephthalate. By E. L. Foster and H. Heap.

Amorphous polyethylene terephthalate will crystallize at elevated temperatures either by the action of the temperature alone or as a result of a stretching process. An apparatus has been constructed by means of which the stress-strain curves of amorphous polyethylene terephthalate in the rubber-like state may be investigated under conditions where the material is heated for a period of not more than one second before the application of the strain. In this way spontaneous crystallization is minimized and the crystallization due to stretching may be studied. The effects of both temperature and straining rate on the shape of the stress-strain curve have been investigated and the results indicate that the crystallization is stress-controlled. The application of the results to the fibre spinning and drawing processes is discussed.

A method of measuring the thermal constants of granular materials. By T. S. E. Thomas.

Thermal constants of granular materials are determined by measuring the temperature changes at the centre and surface of a metal cylinder containing the material. Heat is supplied to the cylinder wall at a constant rate by a resistance winding, and surface heat loss is eliminated by an outer screening tube kept at the same temperature by manual or automatic control.

Measurement of the diffusion rate of hydrogen in nickel. By A. G Edwards

The diffusion rate of hydrogen within nickel has been measured by making observations on the rate of escape of the gas from a hydrogen-soaked nickel wire heated in *vacuo*. The value obtained agrees, within experimental error, with data on solubility and permeation rate through foils interpreted on the assumption that energy barriers to gas penetration through surfaces are small.

On the screen brightness required for high resolution operation of the electron microscope. By A. W. Agar, F.Inst.P.

To determine the relationship between the screen brightness and the regularly obtainable resolution, the screen brightness, measured by a S.E.I. photometer was plotted against the minimum width of Fresnel fringe which was clearly visible all round a circular hole in a carbon film. It was found that there is an optimum fringe width at which the brightness is used most economically. It is also shown that unless the brightness exceeds a certain value (for a given resolution) it is not possible to be certain that this resolution can be attained.

Non-linear forced vibration of a stretched string. By E. W. Lee.

A stretched string clamped at both ends and driven transversely at the centre is found to undergo non-linear oscillations. Discontinuities in the amplitude of the vibration are observed as the driving frequency is changed (jump phenomena) and the frequency at which these jumps occur depends markedly on whether the frequency is being increased or decreased (hysteresis). The behaviour is in qualitative agreement with simple theory.

High vacuum shaft seals, flanged joints and the gassing and the permeability of rubber-like materials. By R. H. V. M. Dawton.

Various designs of high vacuum shaft seals are given and their performance measured by the pressure rate of rise in a closed system. Experiments show that there is little to choose between them from their vacuum performance, although the washer in which a tension spring is embedded is at times to be preferred. A large portion of the leak is condensable, indicating something more complicated than the direct passage of air through the seal. Experiments give measurements of the gassing from rubber-like materials including neoprene and butyl rubber when totally enclosed in a vacuum system, and also measurements of their permeability to gases. All the synthetic materials tested gassed considerably more than did rubber. In the permeability experiments it was found that the time required for gases to pass through diaphragms varies from several minutes to an hour, depending on the gas. The permeability, unlike the gassing effect, is considerably less with the synthetic rubbers tested than with rubber. Data are given of the testing of flanged gasket joints and their effect on a vacuum system during the first twenty hours of pumping when the joint gassing is liable to be confused with a leak. Data are also given on the flange clamping pressure necessary for a tight joint.

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